

Saturn Scatterometry Rev 260

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December 20, 2017

- Sequence: s98
- Rev: 260
- Observation Id: ri_260_1
- Target Body: Saturn

1 Introduction

This memo describes one of the Cassini RADAR activities for the s98 sequence of the Saturn Tour. A sequence design memo provides the science context of the scheduled observations, an overview of the pointing design, and guidelines for preparing the RADAR IEB. A 4.5-hour warmup occurs first using the parameters shown in table 3.

2 CIMS and Division Summary

CIMS ID	Start	End	Duration	Comments
260RI.WARMUP001_RIDER	2017-037T19:02:00	2017-038T01:17:00	06:15:0.0	
260RI.R1DHR.SOUT001_PIE	2017-038T01:17:00	2017-038T03:00:00	01:43:0.0	
260RI.WARMUP002_RIDER	2017-038T03:00:00	2017-038T05:30:00	02:30:0.0	

Table 1: ri_260_1 CIMS Request Sequence

Each RADAR observation is represented to the project by a set of requests in the Cassini Information Management System (CIMS). The CIMS database contains requests for pointing control, time, and data volume. The CIMS requests show a high-level view of the sequence design.

The CIMS requests form the basis of a pointing design built using the project pointing design tool (PDT). The details of the pointing design are shown by the PDT plots on the corresponding tour sequence web page. (See <https://cassini.jpl.nasa.gov/radar>.) The RADAR pointing sequence is ultimately combined with pointing sequences from other instruments to make a large merged c-kernel. C-kernels are files containing spacecraft attitude data.

A RADAR tool called RADAR Mapping and Sequencing Software (RMSS) reads the merged c-kernel along with other navigation data files, and uses these data to produce a set of instructions for the RADAR observation. The RADAR instructions are called an Instrument Execution Block (IEB). The IEB is produced by running RMSS with a radar config file that controls the process of generating IEB instructions for different segments of time. These segments of time are called divisions with a particular behavior defined by a set of division keywords in the config file. Table 2 shows a summary of the divisions used in this observation. Subsequent sections will show and discuss the keyword selections made for each division. Each division table shows a set of nominal parameters that are determined by the

Division	Name	Start	Duration	Data Vol	Comments
a	distant_warmup	00:00:0.0	06:18:0.0	22.5	Warmup
b	distant_radiometer	06:18:0.0	00:04:30.0	0.3	Radiometer quick-steps
c	distant_sar	06:22:30.0	00:00:42.0	9.2	sarh to force cal cycles
d	distant_sar	06:23:12.0	00:10:48.0	142.6	altimeter when close, no target expected
e	distant_sar	06:34:0.0	00:06:0.0	79.2	sarh coming on A-ring
f	distant_sar	06:40:0.0	00:20:0.0	264.0	sarh on A-ring
g	distant_sar	07:00:0.0	00:18:0.0	237.6	sarl on B-ring
h	distant_scatterometer	07:18:0.0	00:06:0.0	36.0	scatt on outer B-ring
i	distant_scatterometer	07:24:0.0	00:09:0.0	48.6	scatt on C-ring
j	distant_scatterometer	07:33:0.0	00:10:30.0	113.4	scatt on C-ring
k	distant_scatterometer	07:43:30.0	00:04:30.0	37.8	scatt on C-ring
l	distant_radiometer	07:48:0.0	00:12:0.0	0.7	Closing Radiometer
Total				991.9	

Table 2: Division summary. Data volumes (Mbits) are estimated from maximum data rate and division duration.

Name	Nominal	Actual	Mismatch	Comments
mode	radiometer	radiometer	no	
start_time (min)	varies	0.0	no	
end_time (min)	varies	378.0	no	
time_step (s)	varies	3600.0	no	Used by radiometer only modes - saves commands
bem	00100	00100	no	
baq	don't care	5	no	
csr	6	6	no	6 - Radiometer Only Mode
noise_bit_setting	don't care	4.0	no	
dutycycle	don't care	0.38	no	
prf (Hz)	don't care	1000	no	
tro	don't care	0	no	
number_of_pulses	don't care	8	no	
n_bursts_in_flight	don't care	1	no	
percent_of_BW	don't care	100.0	no	
auto_rad	on	on	no	
rip (ms)	34.0	34.0	no	
max_data_rate	0.248	0.992	yes	Kbps - set for slowest burst period
interleave_flag	off	off	no	
interleave_duration (min)	don't care	10.0	no	

Table 3: ri_260_1 Div a distant_warmup block

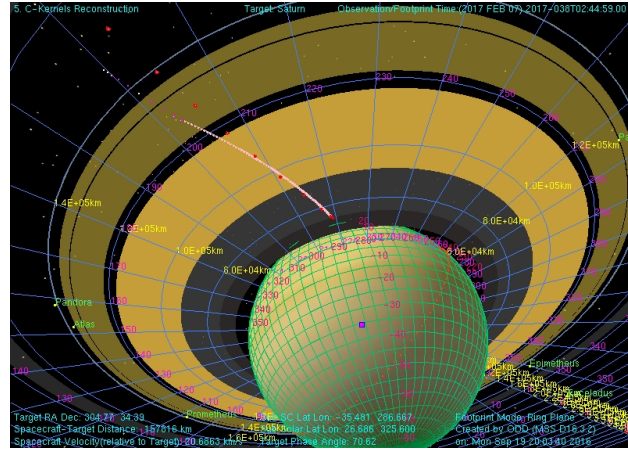


Figure 1: PDT view of RI 260 observation.

operating mode (eg., distant scatterometry, SAR low-res inbound). The actual division parameters from the config file are also shown, and any meaningful mismatches are flagged.

3 Overview

This observation is the first of the active ring scans. It occurs in an F-ring orbit where the spacecraft passes through the ring plane just outside of the rings. The pointing design sweeps the central beam across the rings starting from the outer A-ring when the spacecraft is closest. (See fig. 1) The spacecraft is outbound from the ring plane when the turn to the IVD pointing profile completes and range to the beam footprint varies from around 15000 km to 87000 km. The beam footprint size which sets the real aperture resolution varies from 160 km to 800 km. The beam footprint is moved slowly over the course of a little more than one hour to allow for many looks to accumulate. The pointing design keeps the beam aimed at a point along the line joining the sub-spacecraft point in the ring plane with the center of Saturn. This ensures that iso-range contours in the ring plane will be nearly parallel to iso-radius contours. Range compression processing can then be used to improve radius resolution from the real aperture limit. How much improvement will depend on signal strength, and ambiguity limitations. The radar mode (ie., bandwidth) is varied during this scan to allow for the best possible range resolution. The signal strength was estimated assuming a normalized backscatter of 1.0. The high spacecraft velocity leads to very high doppler shifts, so doppler ambiguities are unavoidable and doppler processing is not expected to be useful. The minimum PRF is also limited by the instrument command parameters, and range ambiguities will also be present in much of the data. Since many looks are accumulated, and the rings are effectively a 1-D target, a deconvolution algorithm should be able to unravel the range ambiguities. Limitations on the number of instructions will also introduce some time domain clipping. The high range to the ring plane requires multiple bursts in flight for the later part of the scan which placed further limitations on the PRF used.

4 Revision History

1. Dec 20, 2017: Initial Release

Name	Nominal	Actual	Mismatch	Comments
mode	scatterometer	sarh	yes	
start_time (min)	varies	394.0	no	
end_time (min)	varies	400.0	no	
time_step (s)	don't care	10.0	no	Valid time calculation used
bem	00100	00100	no	
baq	0	0	no	0 - 8-2 for closer range
csr	0	8	yes	0 - Fixed attenuator
noise_bit_setting	4.0	3.4	yes	Set for 9 dB attenuator
dutycycle	varies	0.70	no	
prf (Hz)	varies	2000	no	Manually set to balance range/doppler ambiguity spacing
tro	6	0	yes	6 - scatt mode only allows 6 for now
number_of_pulses	varies	0	no	Manually set to fill RTT or buffer or exhaust ESS
n_bursts_in_flight	1	1	no	
percent_of_BW	100.0	100.0	no	
auto_rad	on	on	no	
rip (ms)	34.0	34.0	no	
max_data_rate	varies	220.000	no	Kbps - set as high as possible to maximize looks
interleave_flag	off	off	no	
interleave_duration (min)	don't care	10.0	no	

Table 4: ri_260_1 Divide distant_sar block

5 Acronym List

ALT	Altimeter - one of the radar operating modes
BAQ	Block Adaptive Quantizer
CIMS	Cassini Information Management System - a database of observations
Ckernel	NAIF kernel file containing attitude data
DLAP	Desired Look Angle Profile - spacecraft pointing profile designed for optimal SAR performance
ESS	Energy Storage System - capacitor bank used by RADAR to store transmit energy
IEB	Instrument Execution Block - instructions for the instrument
ISS	Imaging Science Subsystem
IVD	Inertial Vector Description - attitude vector data
IVP	Inertial Vector Propagator - spacecraft software, part of attitude control system
INMS	Inertial Neutral Mass Spectrometer - one of the instruments
NAIF	Navigation and Ancillary Information Facility
ORS	Optical Remote Sensing instruments
PDT	Pointing Design Tool
PRI	Pulse Repetition Interval
PRF	Pulse Repetition Frequency
RMSS	Radar Mapping Sequencing Software - produces radar IEB's
SAR	Synthetic Aperture Radar - radar imaging mode
SNR	Signal to Noise Ratio
SOP	Science Operations Plan - detailed sequence design
SOPUD	Science Operations Plan Update - phase of sequencing when SOP is updated prior to actual sequencing
SSG	SubSequence Generation - spacecraft/instrument commands are produced
SPICE	Spacecraft, Instrument, C-kernel handling software - supplied by NAIF to use NAIF kernel files.
TRO	Transmit Receive Offset - round trip delay time in units of PRI